



Scottish Seaweed
Industry Association



CODE OF GOOD PRACTICE

ANNEXES



Code of Good Practice for the Scottish Seaweed Sector

Standard Version History

Version	Date	Reason for Change	Primary Author(s)
WD1.0	February 2025	Working Draft – Version 1.0	RR
FD1.0	November 2025	Final Draft – version 1.0	RR

Annex 1

Hazards

Biological hazards may include pathogens like bacteria, viruses, and parasites. Chemical hazards could involve pesticides, heavy metals, and marine toxins. Physical hazards might include foreign objects such as sand, shells, or plastic.

The following details a list of potential hazards to consider during farming, wild harvesting, and processing. They are by no means exhaustive and serve as a starting point.

Important hazards that may occur in the growing environment of seaweed:

- enteric bacterial pathogens (e.g. *Salmonella* spp.);
- enteric viral pathogens;
- naturally occurring bacterial pathogens;
- biotoxins; and
- chemical contaminants (e.g. heavy metals such as lead, cadmium and mercury)

1. Biological Hazards

Biological hazards involve harmful microorganisms (bacteria, viruses, fungi, and parasites) that may be present in seaweed products, potentially leading to foodborne illnesses.

1.1 Bacterial Contamination

Escherichia coli (E. coli): Can be introduced through contaminated water or handling practices, potentially leading to foodborne illness. Will be found wherever there are sewage inputs, storm overflow events, livestock fields draining to the shore, and small rural treatment works.

Salmonella spp.: Not common, but the same watershed pathways as E. coli. Often associated with faecal contamination.

Listeria monocytogenes: A pathogen that can grow at low temperatures and is often associated with poor sanitation or improper storage. Persists in drains, floors, and conveyors.

Staphylococcus aureus: Human contamination during handling, can be caused by sneezes, cuts, and dirty gloves.

Clostridium botulinum: Can be a concern in improperly stored or preserved seaweed products (e.g., fresh seaweed in vacuum-sealed packages).

1.2 Fungal Contamination

Molds and Yeasts: Can grow on seaweed during storage, especially under high moisture conditions. Fungi may produce mycotoxins which are harmful to human health.

Aspergillus / Penicillium / Cladosporium: risk appears when drying is too slow or storage humidity creeps up. This is a moisture management hazard, it affects quality first, but extended damp storage can create mycotoxin conditions depending on substrate.

1.3 Viruses

Norovirus: Common in aquatic environments and may be transmitted via contaminated water (usually because of untreated wastewater or storm overflows), raw consumption of seaweed increases risk.

1.4 Parasites

Parasite hazards in seaweed are usually incidental:

- Marine protozoa or helminth eggs linked to sewage discharge can attach to fronds, though this is extremely location-dependent.
- Small invertebrates (amphipods, copepods, gastropod eggs) are quality rather than direct health hazards, unless raw consumption introduces allergen risk.
- *Cryptosporidium* and *Giardia* cysts only relevant where waters suffer untreated human or livestock effluent; apply the same control measures as norovirus.

2. Chemical Hazards

Chemical hazards include toxic substances, either naturally occurring in the environment or introduced through human activity, that may contaminate seaweed.

2.1 Heavy Metals

Arsenic (both organic and inorganic forms): Seaweed naturally accumulates arsenic, the majority organic and low toxicity, but some species (especially kelps) contain elevated inorganic arsenic and require monitoring and consumption guidance.

Lead: Can accumulate depending on local geology and historical pollution sources, so site selection and periodic testing may be required.

Cadmium: Can accumulate depending on local geology and historical pollution sources, so site selection and periodic testing may be required.

Mercury: Can accumulate in marine life and subsequently in seaweed.

2.2 Pesticides and Herbicides

Agricultural runoff: Chemicals used in agriculture (e.g., pesticides, herbicides) may contaminate seaweed farms near agricultural areas or during transport from wild harvesting zones.

2.3 Polychlorinated Aromatic Hydrocarbons (PAHs)

PAHs can be introduced from the environment at polluted sites, but they also form during processing if seaweed is dried at high temperatures or exposed to combustion fumes. This is a process control hazard, managed by temperature limits, indirect heat drying, and clean air supply to the dryer.

2.4 Per- and Polyfluoroalkyl Substances (PFAS)

Environmental Pollution: PFAS chemicals can be present in marine environments due to industrial runoff or waste disposal, particularly near industrial or urban areas.

Water Source Contamination: If seaweed farms or harvesting sites are located in areas where PFAS-contaminated water is used, it could lead to the accumulation of these substances in the seaweed biomass.

Transport and Packaging: PFAS could also potentially be present in packaging materials or containers used for seaweed products, especially if non-stick or water-resistant coatings have been used.

2.5 Iodine

Excessive iodine content: While iodine is a natural constituent of seaweed, excessive amounts can pose a health risk. Levels must be monitored, particularly for high-iodine species like kelp.

While there is no [regulatory limit for iodine in seaweed products](#), **the 600 micrograms/day upper intake limit from EFSA and UK guidance serves as a reference**. Seaweed products whose portions

exceed this intake should be clearly labelled, and companies should use risk-based testing and controls to ensure that iodine content in their products is safe for regular consumption.

2.6 Toxins

Marine biotoxins do not bioaccumulate in seaweed, however they may adhere to the surface during harmful algal bloom events. The hazard is situational and controlled through site monitoring and harvest suspension during bloom alerts, with effective washing of raw product.

2.7 Cleaning Agents and Chemical Sanitisers

Chemicals used in cleaning harvesting equipment or processing facilities, such as detergents or disinfectants, may remain as residues if not properly washed off.

3. Physical Hazards

Physical hazards include foreign objects or contaminants that can pose risks to human health when present in seaweed products.

3.1 Foreign Objects

Foreign objects include plastics, netting, line fibres, grit, and fragments of handling materials. Wild seaweed may trap plastic debris, while farmed seaweed most commonly carries rope fibres from cultivation lines. Additional risks include metal, glass, or wood fragments introduced during processing. Controls rely on site cleanliness, harvest handling, structured wash and inspection steps, and equipment maintenance.

3.2 Physical Damage

Physical damage to seaweed during harvest, handling, or storage does not introduce pathogens directly, but it accelerates spoilage by increasing nutrient availability for microbes and reducing shelf life. Control relies on gentle handling, avoiding excessive compression during transport, prompt cooling, and appropriate container size and fill levels.

3.3 Cross Contamination

Cross-contamination occurs when clean seaweed comes into contact with contaminated surfaces, equipment, containers, or hands. The main concern in processing facilities is the transfer of *Listeria*

monocytogenes from drains, floors, and poorly cleaned machinery. Control requires cleanable surfaces, separation of 'dry' and 'wet', 'dirty' and 'clean', routine sanitation, and hygiene training.

3.4 Temperature Abuse

If fresh seaweed is stored warm, microbial growth accelerates rapidly and quality collapses. Temperature abuse also increases the risk associated with non-proteolytic *Clostridium botulinum* when seaweed is packaged in reduced-oxygen formats. Keep raw wet seaweed chilled immediately post-harvest and avoid vacuum or sealed packaging unless time-temperature limits and salt or pH controls are in place.

3.5 Fouling and Overgrowth

Marine fouling organisms such as small shell fragments, bryozoans, amphipods, or epiphytic algae can attach to fronds during cultivation or wild harvest. Control relies on site selection, harvest timing, and post-harvest washing and trimming to remove fouling material before processing.